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ELECTRONIC TECHNICIAN PERSONNEL AND TRAINING NEEDS OF IOWA INDUSTRIES.

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THE PURPOSE OF THIS STUDY WAS TO PROVIDE DATA FOR USE IN DEVELOPING OR IMPROVING ELECTRONIC TECHNOLOGY PROGRAMS. A POSTAL CARD QUESTIONNAIRE WAS SENT TO 678 MANUFACTURING AND PROCESSING INDUSTRIES IN IOWA EMPLOYING MORE THAN 50 PERSONS AND ALL ELECTRICAL, ELECTRONIC, AND PRECISION INSTRUMENT MANUFACTURERS EMPLOYING FEWER THAN 50 PERSONS. DATA WERE COMPILED FROM THE MAIN QUESTIONNAIRE, COMPLETED BY 115 FIRMS EMPLOYING 99,045 PERSONS, AND FROM INTERVIEWS WITH REPRESENTATIVES OF THE 11 INDUSTRIES EMPLOYING 10 OR MORE ELECTRONIC TECHNICIANS. THE FIRMS REPORTED A NEED FOR 205 ELECTRONIC TECHNICIANS BY JANUARY 1, 1968 AND 544 BY 1972. ALTHOUGH A DEFINITE NEED WAS INDICATED, IT VARIED WITH THE SIZE OF INDUSTRY, PRODUCT MANUFACTURED, AND GEOGRAPHICAL LOCATION AND WAS DIFFICULT TO PREDICT BEYOND 1 YEAR. THE MAIN SOURCE OF TECHNICALLY TRAINED ELECTRICAL PERSONNEL WAS IN-COMPANY TRAINING PROGRAMS. QUESTIONNAIRE RESPONSES INDICATED THAT TRAINING IS NEEDED IN NINE BASIC DISCIPLINES--MATHEMATICS, BASIC PRINCIPLES OF PHYSICS, SHOP OPERATIONS AND RELATED INFORMATION, TECHNICAL DRAWING, A-C AND D-C CIRCUITS AND MACHINES, ELECTRONIC COMPONENTS AND CIRCUITS, USE AND REPAIR OF TEST EQUIPMENT, TV CIRCUITS, AND DATA PROCESSING. IT WAS FELT THAT SIMILAR STUDIES SHOULD BE CONDUCTED FOR ELECTRONIC TECHNICIANS IN THE COMMUNICATIONS AND COMPUTER SERVICING INDUSTRIES. (HC)

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ELECTRONIC TECHNICIAN PERSONNEL AND TRAINING NEEDS OF IOWA INDUSTRIES

by

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INTRODUCTION

Throughout the history of the United States, various occupational developments have emerged that have been influenced by various economic and social changes.

The general public has been educated to expect better products from year to year.

Since the cost of labor continues to rise and the human laborer is limited in his output, industries are prompted to mechanize and automate to increase production and quality and to reduce costs. Automation has created new job classifications which entail keeping the automated machines in repair, developing improvements, and adding the improvements in the production schedule.

One of the chief problems to emerge is that of obtaining qualified persons to perform the higher level jobs.

The training of these persons can either be in the industry or by a separate educational institution. Often it is a combination of both.

The establishment of area vocational schools in Iowa has focused attention on the need for research to provide data for development of sound curricula. Since the available specific data for Iowa have been little more than minimal, research on nearly any vocationl-technical topic would be beneficial. The high rate of technological change in the field of electronics in Iowa, as well as in the nation, has emphasized the need for new and better programs in electronic technology. The purpose of this study was to provide data which may be used in any practical way to develop or improve electronic technology programs in

Iowa.

Technicians

There is a demand for the type of worker who is referred to as a technician.

> The term technician, as used in the generic sense, refers to an individual operating in a non-professional capacity whose main concern is the non-theoretical aspects of a technical product. This individual is expected to be intelligent, perceptive and creative. The technically oriented person who can fulfill these requirements will almost certainly be assured of a job in the coming years of increasingly severe job competition. (3, p. 39)

There is no generally accepted definition for the term "technician". "It is applied to employees doing relatively routine work, to persons performing work requiring skills within a limited sphere, and to persons doing highly technical work, among them assistants to engineers and scientists." (29, p. 1)

Whenever terminology does not convey the same meaning to different people, communication between them is difficult, and misunderstandings often arise. In the case of education for technical work, this can be an obstacle of significance since development of educational programs relies heavily on clear communication between industries and institutions. Rather than arriving at a common definition, each author formulates his own and discusses his treatise under his own terminology.

Electronic "technology"

While the general term "technician" commands little agreement in industry and education, various adjectives are used to precede it which tends to narrow the meaning somewhat. However, there is much to be

desired in achieving accurate communication through standard definitions.

Mr. W. M. Arnold, Director of the Area Vocational Education Branch of the Office of Education, discusses the issue by not referring to technicians but by saying (27, p. 1v):

> Graduates of a technical course in electronic technology may work in two broad areas--the field of communications, where they usually specialize in radio, radar, and television; or in manufacturing, where they become specialists in the design, modification, and installation of complex electronic units used in controlling and activating various mechanical systems such as analog and digital computers, servomechanisms, missile guidance systems, and machine tools; in evaluating the operating characteristics of electronic equipment; or in performing trouble shooting functions to locate and correct malfunctioning of electronic equipment. Some may be hired to work in a research laboratory engaged in experimental work for aircraft and missiles. At the outset, they may perform simple, functional tests on electronic units to become familiar with the conventions, techniques, terminology, and other factors peculiar to the industry and to the specific work assignment. They may soon test electronic units under simulated flight conditions, and later be assigned to rework, modify, or adapt electronic units to meet specific engineering and customer requirements.

This approach is, of course, from the point of view of an educator. From the standpoint of industry, it would not begin to adequately describe an electronic technician. Many of the workers who perform the tasks for which electronic technology graduates are prepared have received no formal training. This would tend to indicate that a definition of "technician" should be in terms of performance rather than education.

Training

Few, if any, educational processes have ever taken place which have been entirely without criticism as to their absolute creditability. As

a result of constructive criticism better programs often have been developed.

While it is quite necessary for workers to grasp concepts, it is also necessary for them to take given concepts and extropolate in an extremely creative manner. This point was brought out by Dr. Glenn Bayem, Director of the Navy's Technical Recruitment Program, when he questioned the use of laboratory experiments for technical training (3, p. 41-42).

> For example, it is standard practice for an individual to go through the common experimental setups, as usually found in laboratory courses, and it is postulated that such experience will give the technician familiarity with problems of the type which he may encounter on the job. But, in fact, the Navy has found that this type of experience does not help much when the individual comes face to face with an actual breakdown of equipment. Why is it that laboratory learning does not transfer over into the real working world? Is it possible that much laboratory experience, ostensibly for the purpose of demonstrating basic principles, develops only the fantasy of methodical ultra-simplicity? Dr. Bayem commented that a good deal of research is still needed in order to understand how to balance course content between the general and the specific. Research is needed in the area of transfer of training. For example, to what extent can the technician transfer and apply material learned about an analog system to a digital system or perhaps to a system not yet invented?

Even though technical training, like other education, has met controversy, the Office of Education submitted the following general conditions to be met in curriculum content (27, p. 30).

1. The range of course content for preparation for the jobs in the cluster should be reasonable in view of the total time allotted to the training program.

2. The technical content should lend itself to organized instruction.

3. A substantial part of the total curriculum should be such that it can be mastered by a reasonalby high proportion of students having the necessary educational backgrounds to benefit from the technical training provided.

4. The psychological order of learning should be followed to provide spiral teaching of the subject matter.

5. The curriculum content should include technology of the occupational field, applied science and applied mathematics (applied to the field of work for which the training is provided), and other applied content such as technical report writing, machine design, or other areas which are essential to satisfactory job performance.

6. The various areas of mathematics or science should be integrated so that the application of mathematical or scientific principles may be presented without regard to discrete subjects.

Education and industry

Advancement in this technological age is dependent on the co-ordination of training programs in education and the manpower need of industry. This is not just a matter of appointed advisory committees but a situation of greater involvement such as co-operating committees which do more than advise and joint apprenticeship committees which have some authority. Sound research is the first important phase.

Objectives of this study

The objectives of this study were:

1. To determine the number of industries which employed electronic technicians or may do so in the future.
2. To determine the skills and knowledge which the industries desired their electronic technicans to possess.
3. To determine the number of electronic technicians needed to meet the present and future needs of Iowa industries.
4. To determine the present sources of electronic technicians being hired by Iowa industries.

Definitions

For the purpose of this study the following definitions were used.

Technician An individual who requires specialized knowledge and/or experiences to perform jobs of a technical nature.

Electronic technician An individual whose work requires a significant degree of knowledge of electronics to complete his job requirements such as diagnosing, testing, inspecting, maintaining, etc. This person is ranked between an electrician and electrical engineer in degree of technical proficiency.

METHOD OF PROCEDURE

Introduction

The development of the area vocational school concept in Iowa has emphasized the need for research and information which can be used to develop valid curriculums in the various technical areas. Through discussion with persons most closely associated with vocational education in the State Department of Public Instruction and at Iowa State University, it was established that this study should be in the field of electronics. While other topics were also in need of study, this was thought the most pressing. Due to the size of an all inclusive study of electronic technician needs, the study was limited to manufacturing and processing industries in Iowa.

Funding

The proposal, stating the objectives, preliminary findings, method of procedure, and budget necessary for the study, was submitted to the Iowa Department of Public Instruction Division of Vocational Education State Committee for Research Demonstrations and Experiments in May, 1966. The committee approved the proposal and allocated the funds to cover the expenses.

Procedure

The population was established within workable limits with the most valuable assistance of Mr. Donald W. Beard of the Northern National Gas Company of Omaha, Nebraska. Due to the number of industries involved, it was determined that the population should be limited to all the

manufacturing and processing industries in Iowa which employed over 50 persons and, in addition, the electrical and electronic manufacturers and precision instrument manufacturers from the smallest to 50 employees.

The list of industries was furnished by Northern Natural Gas Company. It included the sizes of the companies by categoreis and the person in charge (president, owner, plant manager, etc.) to whom the first mailing was directed.

From discussions with persons in the field of electronics the author felt that if the study immediately eliminated the position of electricians and electrical engineers, the value of the study might have been severely limited. The reason for this was that while companies employed persons who apparently had skills normally considered to be peculiar to a technician, the company did not have such a job classification. However, they could have had job classifications of electricians, electrical engineers and other jobs indicating need for electrical and electronic training.

At the same time that the postal card survey was being developed, material was also being gathered for the main questionnaire. After numerous discussions with technical education administrators and industrial personnel and after review of previous related questionnaire studies, a rough draft of the questionnaire was developed.

Appointments were scheduled with sixteen industries in Iowa selected by geographic areas and their likeliness of being an employer of technically trained electrical personnel.

In these interviews the person or persons being interviewed were asked questions concerning the increasing of the cooperation of industries. They were also asked to review the rough draft of the postal card questionnaire and the main questionnaire. Their comments and suggestions were used to develop the final instruments. This contributed a great deal to the success of the study.

The final form of the double postal card questionnaire was mailed to 678 manufacturers and processors which employed a total of over 160,000 persons. The final return was 62.8%.

The main questionnaire was mailed to 231 industries. The check list was used in the first part to establish the importance of topics which might be needed by electrically trained persons in each company.

Part two of the questionnaire was primarily for gathering information about the company itself. Included here were the company's products, employment data, and terminology used in the company. The return was 89.6%. The final group of 115 industries included all but four of the 24 firms in the original list which employed over 1,000 persons.

To obtain additional information representatives from the 11 industries which reported employing ten or more electronic technicians were interviewed.

Questions were asked which generally related to the availability of electrically trained persons, their familiarity and impressions of current vocational and technical programs, and their observations of trends which might influence future technical education programs.

The companies interviewed employed 1,118 of the 1,274 electronic technicians employed by the industries that returned a completed questionnaire.

FINDINGS

The purpose of this study was to determine Iowa's industries' needs for specially trained persons in the field of electronics. The findings are given in four divisions to fulfill the objectives of the study. The divisions are: 1) information about respondents, 2) number of electrically trained personnel need by industries, 3) sources of electrically trained personnel, and 4) training requirements of the industries.

The element common to all respondents was that the industries were considered to be manufacturers. Beyond this there was considerable diversity in their characteristics.

General Findings

General findings concerning respondents

The industries included in the final tally reported a total employment of 99,045 persons. This number represented about 60% of the employees in the original population. Although the category of 101 to 250 employees had the largest number of industries, the majority of the total employees were in industries employing over 1,000 persons. Each area had at least one industry located within its boundaries as is indicated by the totals. However, 47.8% of the industries were located in areas IX, X, and XI (Appendix). The two digit Standard Industrial Classification Code was used to classify the products. Just over 60% of the industries manufactured products in three product classifications: food and kindred products; machinery except electrical; and electrical machinery, equipment, and supplies. These three groups were fairly well represented in

the various areas with the exception of areas III and XIV which each had only one industry in the three large product classifications.

Table 1. Distribution of responding industries by major product manufactured and merged areas in Iowa

SIC Number	Product Classification	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	Total
19	Ordnance and Accessories							1									1	2
20	Food and Kindred Products	1	2		1	1	1	2		4	3	3	1			1		20
24	Lumber and Wood Products					1			2									3
25	Furniture and Fixtures									1								1
26	Paper and Allied Products						1											1
27	Printing, Publishing and Allied Industries											3						3
28	Chemicals and Allied Products						1			2	1						1	5
30	Rubber and Misc. Plastics Products											2						2
32	Stone, Clay, and Glass Products		2			3				1		1					1	8
33	Primary Metal Industries									2								2
34	Fabricated Metal Products						3			2		2				1	1	9
35	Machinery Except Electrical	1	2			1		4	1	3	4	7		1	1	2		27
36	Electrical Machinery, Equipment, and Supplies	1	1		1	1			1	1	3	5	2	1		1	5	23
38	Professional, Scientific, and Controlling Instruments			1			1			2	1							5
39	Miscellaneous Manufacturing Industries			1					1			2						4
	Total	3	7	2	2	8	6	7	5	18	12	25	3	2	1	5	9	115

Table 2. Distribution of responding industries by size and merged area in Iowa

Size by Numbers of Employees	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	Total
1-10											2		1				3
11-25						1			1								2
26-50	1				1					2	2						6
51-100						1	1	1	2	2	2			1		1	11
101-250	2	4	1	1	2	2		2	2	3	8	1	1		2	3	34
251-500		1	1		4		2	1	6	2	1				1	1	20
501-1000		1		1	1	2			4	1	5	2				2	19
over 1000		1					4	1	3	2	5				2	2	20
Total	3	7	2	2	8	6	7	5	18	12	25	3	2	1	5	9	115

Table 3. Composite of employment data obtained from the questionnaire

Employees	Employed Jan .1, 1965	Employed Jan. 1, 1967	Additonal Needed by Jan. 1, 1968	Additional Needed by Jan. 1, 1972[a]
Electronics Technician	1,013	1,274	205	544[b]
Electricians	838	939	161	352[b]
Electrical Engineers	670	757	79	376[b]
Other Electrically trained Personnel	260	338	38	165[c]
Total Employees	88,363	99,045	6,180	10,339[d]

N = 115

[a]All industries in the study were not able to provide this information.

[b]94 out of 115 industries answered.

[c]96 out of 115 industries answered.

[d]61 out of 115 industries answered.

Table 4. Employment of electrically trained personnel and total employment by major product manufactured

	Product Classification	Electronic Technician	Electrician	Electrical Engineer	Other Electrically Trained Personnel	Total Employees
19	Ordnance and Accessories	20	64	8	70	5,062
20	Food and Kindred Products	0	154	10	66	19,978
24	Lumber and Wood Products	2	8	1	3	648
25	Furniture and Fixtures	0	1	1	1	600
26	Paper and Allied Products	0	3	0	0	175
27	Printing, Publishing, and Allied Industries	0	19	0	8	2,683
28	Chemical and Allied Products	12	54	7	7	2,700
30	Rubber and Misc. Plastics Products	0	47	4	13	3,800
32	Stone, Clay, and Glass Products	4	32	4	25	1,633
33	Primary Metal Industries	0	121	15	0	4,000
34	Fabricated Metal Products	28	10	9	31	2,818
35	Machinery Except Electrical	26	241	12	68	28,198
36	Electrical Machinery, Equipment and Supplies	1,108	140	649	32	23,093
38	Professional, Scientific, and Controlling Instruments	73	8	35	5	2,706
39	Miscellaneous Manufacturing Industries	1	37	2	9	951
	Total	1,274	939	757	338	99,045

Table 5. Additional electrically trained personnel and total employee needs by major product manufactured January 1, 1968

	Product Classification	Electronic Technician	Electrician	Electrical Engineer	Other Electrically Trained Personnel	Total Employees
19	Ordnance and Accessories	3	13	1	0	999
20	Food and Kindred Products	0	22	2	7	510
24	Lumber and Wood Products	1	2	0	0	52
25	Furniture and Fixtures	0	1	0	1	100
26	Paper and Allied Products	0	0	0	0	0
27	Printing, Publishing, and Allied Industries	0	3	0	2	50
28	Chemical and Allied Products	1	16	2	1	335
30	Rubber and Misc. Plastics Products	0	2	0	2	0
32	Stone, Clay, and Glass Products	0	3	2	1	0
33	Primary Metal Products	0	16	3	0	999
34	Fabricated Metal Products	5	3	4	3	160
35	Machinery Except Electrical	14	38	9	14	908
36	Electrical Machinery, Equipment, and Supplies	171	34	46	6	1,677
38	Professional, Scientific, and Controlling Instruments	8	1	10	1	241
39	Miscellaneous Manufacturing Industries	2	7	0	0	149
	Total	205	161	79	38	6,180

Table 6. Employment of electrically trained personnel and total employees by merged area

Area	Electronic Technician	Electrician	Electrical Engineer	Other Electrically Trained Personnel	Total Employees
I	4	2	3	5	355
II	12	47	4	7	4,688
III	0	4	0	5	734
IV	4	1	1	0	805
V	2	18	3	31	2,413
VI	7	8	6	7	2,140
VII	5	131	3	81	16,862
VIII	2	64	6	8	5,430
IX	113	250	69	36	13,886
X	952	57	604	0	19,024
XI	19	232	22	131	16,954
XII	53	13	7	2	2,000
XIII	8	1	2	0	184
XIV	0	1	0	5	65
XV	9	34	4	13	5,585
XVI	84	76	43	7	7,920
Total	1,274	939	757	338	99,045

Table 7. Additional electrically trained personnel and total employeed needs by merged area January 1, 1968

Area	Electronic Technician	Electrician	Electrical Engineer	Other Electrically Trained Personnel	Total Employees
I	0	3	0	1	40
II	0	6	2	0	250
III	0	1	0	1	116
IV	0	1	0	0	0
V	2	5	0	1	162
VI	2	2	2	0	8
VII	5	22	3	3	370
VIII	1	2	0	0	80
IX	9	49	16	10	1,613
X	121	12	36	0	1,147
XI	8	33	6	17	353

Table 7 (Continued)

Area	Electronic Technician	Electrician	Electrical Engineer	Other Electrically Trained Personnel	Total Employees
XII	32	3	1	1	500
XIII	7	1	1	0	7
XIV	0	0	0	0	0
XV	6	10	4	3	150
XVI	12	11	8	1	1,384
Total	205	161	79	38	6,180

There was a proportionally greater need for electrically trained personnel than over-all employment needs. The number of additional electricians needed January 1, 1968, as a percentage of those employed January 1, 1967, was 17.1%. The corresponding percentages for the other electrically trained employees were: electronic technicians, 16.1%; other electrically trained personnel, 11.2%; and electrical engineers, 10.4%. For all employees in the reporting industries the percentage was 6.2%.

Total employee data indicate another high concentration in a small number of areas with two-thirds of the total employees in four areas: area X, 19,024; area XI, 16,954; area VII, 16,862; and area IX, 13,886.

The greatest need for electronic technicians was in area X which constituted 59% of the total additional needed by January 1, 1968.

All of the industries in five areas (I, II, III, IV, and XIV) reported that no electronic technicians would be needed in one year.

Sixty-one percent of the total additional employees were needed in just three areas: IX, X, and XVI. Industries in areas VII and XI indicated a somewhat lower total need in proportion to the number of workers employed

at the time of the survey.

The industries reported an immediate need of 202 electrical personnel and 66 non-electrical personnel.

Table 8. Sources of personnel who perform electronic technician work in Iowa industries

Source	Yes	No	Total
In-Company Training Programs	96 (83.5%)	19 (16.5%)	115 (100%)
Technical School	69 (60.0%)	46 (30.0%)	115 (100%)
Other Companies	64 (55.6%)	51 (44.4%)	115 (100%)
Military Service	48 (41.7%)	67 (58.3%)	115 (100%)
Other Sources	12 (10.4%)	103 (89.6%)	115 (100%)
Upgrade Employee	3		
Job Applicants	2		
Universities	2		
Apprenticeship	1		
Community College	1		
Employment Service	1		
TV Service	1		
Any Place	1		

The most frequently used term to describe technically trained electrical personnel was electrician. Fifty-one and three-tenths percent used this term. As a group the non-electrical terms were the next most frequently used with 49.5% of the responding industries reporting one or more.

Training needs for electronic technicians

In this portion of the findings the opinions of the persons completing the questionnaire are presented in regard to training needed in nine basic disciplines. The categories are: 1) mathematics, 2) basic principles of physics, 3) shop operations and related information, 4) technical drawing,

5) a-c and d-c circuits and machines, 6) electronic components and circuits, 7) use and repair of test equipment, 8) TV circuits, and 9) data processing.

Tables 9 through 17 give the composite ratings of the training needs by the 115 industries in the stuyd. The number indicating each rating, one through five, is given along with the average for each topic. The rating scale is as follows: 1) very little importance, 2) background only, 3) desirable, 4) highly desirable, and 5) essential.

Table 9. Importance of mathematics for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
Algebra	6	12	28	22	<u>47</u>	3.80
Trigonometry	10	10	32	28	<u>35</u>	3.59
Analytical geometry	31	21	<u>32</u>	23	8	2.61
Logarithmic and exponential functions	<u>42</u>	23	22	21	7	2.37
Vector algebra	<u>37</u>	27	31	14	6	2.35
Elementary statistical analysis	<u>55</u>	21	25	12	2	2.00
Binary notation	<u>60</u>	21	17	11	6	1.97
Differentiation	<u>53</u>	31	22	9	0	1.88
Integration	<u>57</u>	32	17	9	0	1.81
Boolean algebra	<u>68</u>	22	15	7	3	1.74
Laplace transforms	<u>72</u>	28	13	2	0	1.54
Hyperbolic functions	<u>64</u>	31	15	5	0	1.53

N = 115

Rating:

1 - Very little importance
2 - Background only
3 - Desirable
4 - Highly desirable
5 - Essential

Predominant response for each item is underscored

Table 10. Importance of basic principles of physics for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
Simple machines	8	10	26	29	42	3.76
Work and power	11	13	30	21	40	3.57
Forces	10	17	33	18	37	3.48
Motion	11	16	35	19	34	3.43
Fluids	19	18	26	30	22	3.11
Strength of material	19	23	36	21	16	2.93
Heat and thermodynamics	26	29	27	21	12	2.69
Physical chemistry of metal	40	30	26	15	4	2.24
Light, lenses, and colormetry	47	29	24	11	4	2.09
Wave propagation	54	29	15	10	7	2.01
Electro-acoustics	52	32	18	8	5	1.93

N = 115

Table 11. Importance of shop operations and related information for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
Soldering	4	4	16	24	67	4.27
Drilling	3	11	33	28	40	3.79
Measuring with micrometers	5	13	27	33	37	3.74
Sheetmetal fabrication	10	18	35	24	28	3.37
Arc welding	13	17	32	27	26	3.31
Spot welding	13	18	30	29	25	3.30
Oxyacetylene welding	13	20	34	24	24	3.23
Boring	14	23	34	24	20	3.11
Facing	17	22	36	22	18	3.08
Turning	16	23	32	24	20	3.07

Table 11 (Continued)

Topic	Rating					
	1	2	3	4	5	Average
Milling	18	25	31	22	19	2.99
Shaping	19	27	29	22	18	2.94
			N = 115			

Table 12. Importance of technical drawing for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
Blueprint reading	4	3	14	20	74	4.37
Electronic symbols	8	9	22	22	54	3.91
Schematic diagram simplification	9	9	23	34	40	3.76
Electronic circuit drawing	12	9	22	28	44	3.72
Dimensioning	11	4	34	26	40	3.70
Sketching	8	7	32	32	36	3.69
Charts and graphs	11	16	32	31	25	3.37
Pictorial drawings	12	13	37	27	26	3.37
Theory of projection	18	11	37	23	26	3.24
Reproduction of drawings	19	19	43	16	18	2.96
Technical illustrating	22	21	32	21	19	2.94
Fasteners	24	18	43	14	16	2.87
			N = 115			

Table 13. Importance of a-c and d-c circuits and machines for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
Series and parallel circuits	4	4	16	13	78	4.37
Combination circuits	6	6	15	20	68	4.20
Circuit laws	9	8	23	26	49	3.85
Generators and motors	11	11	13	30	50	3.84
Inductive reactance, resonance, capacitance, etc.	10	10	26	21	48	3.76
Multiphase systems	18	17	24	26	30	3.29
Integrating circuits	33	26	24	14	18	2.63
Differentiating circuits	33	26	28	10	18	2.60
Transient analysis	37	33	20	13	12	2.39
Vector analysis	37	31	23	14	10	2.38

N = 115

Table 14. Importance of electronic components and circuits for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
A-C and d-c power supplies	4	2	16	29	64	4.28
Power supply regulation	7	9	13	29	57	4.04
Diodes (semiconductor)	20	9	17	23	46	3.57
Transistors (semiconductor)	21	9	19	26	40	3.48
Diodes (vacuum tube)	21	12	23	24	35	3.38
SCR's (semiconductor)	24	9	17	30	35	3.37
Triodes (vacuum tube)	23	11	23	24	34	3.30
Switching circuit analysis	19	12	36	20	28	3.23
Tetrodes (vacuum tube)	26	13	23	23	30	3.16
Vacuum tube circuit analysis	23	12	30	23	27	3.16

Table 14 (Continued)

Topic	Rating					
	1	2	3	4	5	Average
Pentode (vacuum tube)	26	13	24	22	30	3.15
Unijunction transistors (semiconductor)	28	14	24	19	30	3.08
Field effect transistors (semiconductor)	30	17	20	22	26	2.97
Oscillator circuits	27	22	26	12	28	2.93
Transistor analysis	30	21	20	20	24	2.89
Audio amplifiers	26	21	32	13	23	2.88
Switching circuit design	28	21	29	18	19	2.82
Radio frequency amplifiers	32	25	28	9	21	2.67
Vacuum tube circuit design	35	19	32	13	16	2.61
Transistor design	42	31	17	10	15	2.35
FM modulation	51	25	25	3	11	2.11
AM modulation	49	29	24	2	11	2.10
Antennas and antenna systems	72	18	13	6	6	1.75
Waveguides	79	20	9	2	5	1.56
			N = 115			

Table 15. Importance of use and repair of test equipment for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
A-C and d-c voltmeters	4	5	17	22	67	4.24
A-C and d-c ammeters	4	5	18	22	66	4.22
Ohmmeters	11	5	13	24	62	4.05
Wattmeters	13	8	21	22	51	3.78
Vacuum tube voltmeters	19	6	18	19	51	3.65
Oscilloscopes	21	8	23	25	38	3.37

Table 15 (Continued)

Topic	Rating					
	1	2	3	4	5	Average
Tube and transistor testers	24	9	23	18	41	3.37
D-C bridges	25	8	24	25	33	3.29
Counters	20	13	27	28	27	3.25
A-C bridges	35	14	31	13	22	2.77
Voltage and current standardizing equipment	31	18	29	22	15	2.76
Signal generator below microwave frequencies	40	24	20	12	19	2.53
Wave form generators	44	29	22	7	13	2.27
Function generators	48	23	25	9	10	2.22
Modulators and demodulators	52	27	18	9	9	2.17
Q meters	58	25	13	11	8	2.01
Frequency analyzers	58	21	21	9	4	1.85
Ratiometers	59	24	13	13	6	1.98
Field strength meters	58	26	16	8	7	1.97
Precision frequency measuring equipment	61	26	11	6	11	1.96
Pulse analyzers	62	25	15	8	5	1.93
Distortion analyzers	63	23	16	9	4	1.85
Variable frequency b pass	69	23	13	5	5	1.73
Microwave signal generators	67	19	19	4	6	1.72
Shorting stubs and other wave guid loads	74	21	12	5	2	1.63
Interpolation oscillators	73	25	10	5	2	1.59

N = 115

Table 16. Importance of TV circuits for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
Picture transmission	74	22	12	4	3	1.61
Pulse limiters, sweep generator	74	25	10	2	4	1.58
Color TV	82	23	4	3	3	1.45
			N = 115			

Table 17. Importance of data processing for electronic technicians

Topic	Rating					
	1	2	3	4	5	Average
Computer logic	46	19	26	17	7	2.30
Tape and recording equipment	52	19	23	15	6	2.17
Memory systems	52	23	16	18	6	2.16
Teletype	57	22	19	14	3	1.99
			N = 115			

SUMMARY AND CONCLUSIONS

The development of the area vocational school concept in Iowa has created a need for research to provide data on which to develop sound educational programs. Funds were made available for this study through the combined efforts of the Iowa Department of Public Instruction of Vocational Education and Iowa State University.

This study, with the purpose of contributing data to meet the research need, had the following objectives:

1. To determine the number of industries in Iowa which employed electronic technicians or may do so in the future.
2. To determine the skills and knowledge which the industries desired their electronic technicians to possess.
3. To determine the number of electronic technicians needed to meet the present and future needs of Iowa industries.
4. To determine the present sources of electronic technicians being hired by Iowa industries.

In order to fulfill these objectives, a postal card questionnaire was mailed to 678 manufacturing and processing industries in Iowa whose names were obtained from the Northern Natural Gas Company of Omaha, Nebraska. One hundred and fifteen industries, to which the study applied, completed the main questionnaire which, along with personal interviews, provided the data and supporting information for this study.

The manufacturing industries in this study employed a total of 99,045 persons. A majority of the employees were located in industries

employing over 1,000 persons. Forty-seven and eight-tenths percent of the industries in the study were located in areas IX, X, and XI. Forty and eight-tenths percent of the industries were located in four counties. Sixty percent of the industries were engaged in manufacturing in the three Standard Industrial Classifications of: 1) food and kindred products; 2) machinery except electrical; and 3) electrical machinery, equipment, and supplies.

There was aproportionally greater need for electrically trained personnel than for all other workers as a group. The percentage increase needed for various electrically trained personnel from January 1967, to January 1968, was: 1) electricians, 17.1%; 2) electronic techncians, 16.1%; 3) other electrically trained personnel, 11.2%; and 4) electrical engineers, 10.4%. The predicted percentage increase needed for all employees in the reporting industries was 6.2%. The greatest needs expressed as a percentage of the present employment were found to be in the 251-500 employee size classification.

The industries reported that 205 electronic technicians were needed by January 1, 1968. Ninety-four of the 115 industries reported that by 1972, 544 electronic technicians would be needed.

A large majority of the technicians were employed in the electrical machinery, equipment, and supplies manufacturing industries; and they had the greatest needs for additional technicians. The food and kindred products industries employed a total of 19,978 workers but no electronic technicians. Area X needs were 59% of the total reported for electronic technicians.

The main source of technicians was in-company training programs. The second most frequently used source was technical schools.

A wide variety of terms were used by the industries to describe personnel doing technical work. Electrician was the most frequently used term and was used by 40% of the industries.

Algebra and trigonometry were the only mathematics topics of any significance for electronics technicians.

The basic principles of physics which were rated highest were simple machines, work and power, forces, and motion. The physics principle listed which was closest to electricity, electro-acoustics, received the lowest rating.

Shop operations and related information as a group, along with principles of physics and technical drawing, rated rather high. Soldering was the operation rated highest followed in importance by drilling, measuring with micrometers, sheetmetal fabriaction and the various types of welding.

Blueprint reading ranked number one in importance of technical drawing topics for electronic technicians. Electronic symbols was rated second high. Next in the order of importance were schematic diagram simplification, electronic circuit drawing, dimensioning, and sketching.

Series, parallel, and combination circuits, circuit laws, and generators and motors were considered to be the most important of the a-c and d-c circuits and machines topics in the study. The more complex topics ranked lower.

The four highest rated electronic components and circuits topics in the study were a-c and d-c power supplies, power supply regulation, semiconductor diodes, and transistors. Communication topics, in general, were at the bottom of the list.

In the category of use and repair of test equipment for electronic technicians, a-c and d-c voltmeters, a-c and d-c ammeters, and ohmmeters ranked first, second, and third followed by wattmeters and vacuum tube voltmeters. Many of the more specialized test equipment topics rated rather low.

The topics in the TV circuits category rated very low, and the data processing topics did not rate much higher.

Several noticeable trends appeared when the data were analyzed by size, product manufactured, term used, and area in which the industries were located. In general the larger industries rated the importance of most items higher than the smaller industries.

The importance of the various topics was somewhat varied when the data were presented by the product manufactured by the responding industries. Mathematics was rated highest by the fabricated metal products manufacturers while the highest ratings for basic principles of physics and technical drawing were by ordnance and accessories and professional, scientific, and controlling instruments manufacturing industries. For the electrical topics the highest ratings were not given by the electrical machinery, equipment, and supplies manufacturing industries, as might have been expected, but were distributed among the other manufacturing industries.

The most noticeable point when the data were presented by electrically trained employees in the industries was that the importance of mathematics and the electrical and electronic topics were rated higher for the technicians than for the electrical engineers.

From this study the following conclusions were drawn:

1. The manufacturing industries of Iowa have a definite need for well trained persons in the field of electronics.
2. The training needs vary with the size of the industry, product manufactured, and geographical location.
3. It is very difficult for industries to predict the number of additional employees needed beyond one year.
4. The main source of technically trained electrical personnel is in-company training programs.
5. There is a lack of agreement as to terminology used to describe technically trained electrical personnel in manufacturing industries.

As for further studies related to this one, it was felt that similar studies should be conducted for electronic technicians in the communications industries and the computer servicing industries.

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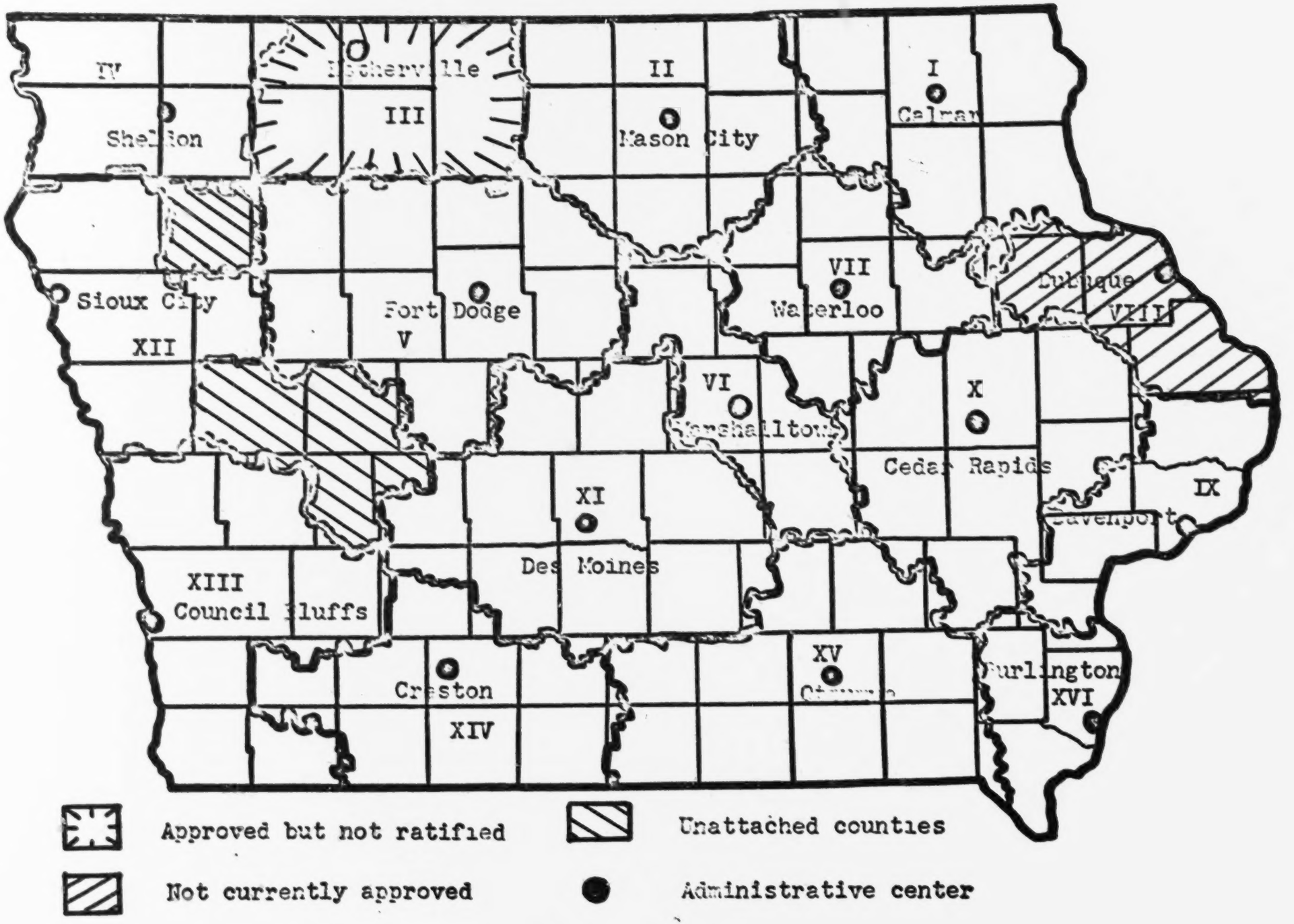
APPENDIX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Marshalltown
Cedar Rapids
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Davenport
Des Moines
XIII
Council Bluffs
XV
Burlington
XVI
Creston
XIV
Approved but not ratified
Unattached counties
Not currently approved
Administrative center